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The Object Classification Task for Children (OCTC): A Measure of Concept Generation and Mental Flexibility in Early Childhood

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In this study, the development of concept generation and mental flexibility was investigated in 84 Australian children between 3 and 7 years of age, using the Object Classification Task for Children (OCTC), a newly developed executive function test for use with young children. On this task, which was adapted from the Concept Generation Test (Levine, Stuss, & Milberg, 1995) and the Concept Generation Test for

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Children (Jacobs, Anderson, & Harvey, 2001), children were asked to categorize 6 plastic toys according to 3 predetermined groupings (i.e., color, size, and function). The test included 3 performance levels, each providing increasing levels of structure for the child. Findings from the OCTC show meaningful age-related changes in performance across age groups, with older children being less dependent on additional structure to complete the task, in comparison to younger children. Furthermore, findings from this study suggest that the ability to generate concepts emerges between 3 and 4 years of age, continuing to develop beyond the age of 7 years. A developmental spurt in cognitive flexibility was observed around 4 to 5 years of age, with refinement of this capacity occurring between 5 and 7 years of age. Results suggest that the OCTC is a useful measure of conceptual reasoning skills in early childhood.

The term *executive function* is often used as a label for a set of psychological processes necessary for adaptive and future-oriented behavior. Although cognitive capacities included vary across definitions, the construct of executive function generally denotes a range of "high-level" thought processes, such as planning, problem solving, initiation of action, self-monitoring, inhibition of automatic responses, and self-regulation. These psychological processes allow the individual to coordinate the activities required to attain a goal: to formulate intentions, develop action plans, implement strategies to execute those plans, monitor performance, and evaluate actions (e.g., Glosser & Goodglass, 1990; Levin et al., 1991; Luria, 1973; Stuss, 1992; Stuss & Benson, 1987). In addition, executive skills are also implicated in social–emotional processes, such as the modulation of emotions, personal and social decision making, perspective taking, affect, and social self-awareness (e.g., Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Anderson, Damasio, Tranel, & Damasio, 2000; Barrash, Tranel, & Anderson, 2000; Benton, 1991; Damasio, 1998; Eslinger, Biddle, & Grattan, 1997; Eslinger & Damasio, 1985; Eslinger, Grattan, Damasio, & Damasio, 1992; Stuss & Alexander, 2000). Thus, executive function is an umbrella term that encompasses multiple functional processes that are necessary for adaptive and future-oriented behavior.

Conceptual reasoning skills, which fall within the domain of executive function, are required in a number of cognitive activities, such as distinguishing what is relevant from what is irrelevant, following general rules, and making use of existing knowledge in a new situation. According to Siegler (1991), conceptual processes encompass the capacity to perceive an abstract concept, or set of concepts, and then shift flexibly between competing concepts or dimensions. Findings from case studies and neuroimaging research suggest that these processes are largely mediated by the frontal lobes, in particular the dorsolateral region of the prefrontal cortex (e.g., Lombardi et al., 1999; Stuss et al., 2000). It is believed that both left and right dorsolateral regions of the prefrontal cortex are involved in cognitive flexibility (e.g., Alexander & Stuss, 2000; Grattan & Eslinger, 1991); however, lateralization of shifting behavior has also been observed. For example, decreased verbal fluency has been associated with damage to the left dorsolateral area (e.g., Borkowski, Benton, & Spreen, 1967; Butler, Rorsman, Hill, & Tuma, 1993; Laine, 1988), whereas impaired performance in nonverbal divergent thinking has been associated with damage to the right dorsolateral area (e.g, Guilford, Christensen, Merrifield, & Wilson, 1978).

The Wisconsin Card Sorting Test (WCST; Berg, 1948; Grant & Berg, 1948) is a neuropsychological task, which has been widely used to assess cognitive processes that are believed to be mediated by the dorsolateral prefrontal cortex (e.g., Cicerone, Lazar, & Shapiro, 1983; Lombardi et al., 1999; Nelson, 1976; Stuss et al., 2000). Other tests of conceptual skills include the Category Test (Halstead, 1947; Reitan & Wolfson, 1993), Identification of Common Objects (commonly referred to as the "Twenty Questions Test"; Laine & Butters, 1982), Raven's Progressive Matrices (Raven, 1960; Raven, Court, & Raven, 1976), the Color Form Sorting Test (Goldstein & Scheerer, 1941, 1953; Weigl, 1941), and the Contingency Naming Test (Taylor, Albo, Phebus, Sachs, & Bierl, 1987). Whereas some of these tests focus primarily on abstract concept formation (i.e., Category Test and Raven's Progressive Matrices), others also include a requirement to shift between competing concepts (i.e., Contingency Naming Test, Twenty Questions Test, and WCST).

A number of traditional adult-based tasks have also been applied in child neuropsychological studies to investigate the development of conceptual reasoning skills in children. Using the WCST, for example, Chelune and Baer (1986) found that children between 6 and 10 years showed marked improvements in their performance, with children older than 10 years performing at adult level. These findings were replicated by Welsh, Pennington, and Groisser (1991), who demonstrated that adult-level skill on the WCST was attained by age 10, with considerable improvement occurring between the ages of 7 and 8 years. Similar results were reported by Levin et al. (1991), who found that the number of more efficient and goal-directed "constraint-seeking" questions on the Twenty Questions Test increased significantly between the ages of 7 and 15 years. Taken together, these findings support the proposition that conceptual reasoning skills develop rapidly during the middle childhood years.

Although a number of studies have investigated conceptual reasoning skills in middle childhood, the development of these cognitive processes in children younger than 7 years has received relatively little attention. Interest in this area has recently burgeoned; however, there remains a paucity of appropriate measures to assess concept generation and cognitive flexibility in young children. Most traditional measures that purport to tap these capacities have been developed for older children and adults. As a result, many are inappropriate or irrelevant for use with children younger than 7 years, where many lower order skills have not yet emerged (e.g., language, literacy, number skills). Adult measures often require a number of complex instructions, thereby placing a large demand on working memory capacity and receptive language{151}skills that are relatively immature in young children. Furthermore, traditional measures are not particularly sensitive to developmental changes in early childhood (e.g., Chelune & Baer, 1986), and therefore, little normative data with respect to the performance of young children are available. Recently, a number of researchers have attempted to overcome these difficulties by developing new, developmentally appropriate assessment tools to evaluate the maturation of conceptual reasoning skills in young children. For example, to investigate inhibition and switching processes in preschoolers, Espy (1997) used the Shape School, a storybook that requires the child to name figures, according to particular (inhibition and shifting) rules. Regarding switching efficiency, Espy found that performance improved significantly between 4 and 5 years of age. Similar findings were reported by Jacques and Zelazo (2001), who investigated switching processes in children between 3 and 5 years using a task called the Flexible Item Selection Task (FIST). This test requires children to select two cards from a set of three cards, according to a common dimension (i.e., size, number, shape, or color). Then, using the same set of cards, children have to select a different pair of cards that match each other on a different dimension. Jacques and Zelazo found that 3-year-olds had difficulty identifying a common dimension in two nonidentical cards, whereas 4-year-olds performed as well as 5-year-olds on this task. Selecting a different pair of cards (so that one card needed to be sorted according to two different dimensions), however, appeared to be very difficult for 4-year-olds, with 5-year-olds outperforming them on this task. Thus, it appears that these skills are developing rapidly during the preschool period, with children between the ages of 3 and 4 years becoming capable of identifying a common dimension in two nonidentical items, and the ability to switch between different concepts emerging after the age of 4 years.

Although the studies by Espy (1997) and Jacques and Zelazo (2001) have provided important insights about the developmental course of conceptual reasoning skills in preschoolers, there is still a gap in our understanding of how these cognitive processes develop across the relatively broad age range of early childhood—from age 3 through age 7. The aim of this study was to investigate the development of conceptual reasoning in children between 3 and 7 years, using a new task with parameters appropriate for children in this age range. This test, the Object Classification Task for Children (OCTC) was based on the paradigms of the Concept Generation Test (CGT; Levine, Stuss, & Milberg, 1995) and the Concept Generation Test for Children (CGT–C; Jacobs, Anderson, & Harvey, 2001), which was developed for children between 7 and 15 years. In these conceptual reasoning tasks, participants are required to generate a number of "sorts" according to some common feature. Whereas the CGT is a pencil-and-paper task of sorting behavior, the task devised by Jacobs et al. uses pictorial stimuli that can be manipulated by children. In this task, children are required to sort pictures according to six predetermined groupings of varying complexity, such as animal habitat and direction of lines. As with the CGT, the CGT–C has three conditions with increasing structure to allow for greater fractionation of the underlying cognitive processes contributing to conceptual reasoning skills, including sorting behavior and mental flexibility. Although the OCTC is similar to these concept-generation tasks, it differs in the following ways: (a) The OCTC uses plastic toys, which can be manipulated by the child and are thought to be more appealing to young children than diagrams or graphics; (b) it has two practice trials, which allow for investigating whether children are able to make two groups without the requirement of identifying a common feature; (c) the OCTC contains two different settings (i.e., a setting with four toys and a setting with six toys), which allow for the examination of conceptual reasoning skills in very young children; and (d) it has only three predetermined groupings (i.e., color, size, and function). It was hypothesized that younger children would perform more poorly on the task, due to the relative immaturity of conceptual reasoning skills. It was also predicted that there would be age-related differences in the ability to generate concepts and in the capacity to shift between concepts. Finally, it was postulated that older children would require less additional structure than younger children to perform successfully on this task.

METHOD

Participants

The sample consisted of 84 children, aged between 3 years 1 month and 7 years 9 months. This sample was divided into five age groups: 3-year-olds (n = 19), 4-year-olds (n = 19), 5-year-olds (n = 14), 6-year-olds (n = 22), and 7-year-olds (n = 10). Children were selected from several local child care centers, kindergartens, and primary schools in the metropolitan area of Melbourne, Australia. Inclusion criteria were: (a) aged between 3 years 0 months and 7 years 11 months at time of testing; (b) no previous history of developmental, neurological, or psychiatric disorder; and (c) English as a first language. Informed consent, based on agency ethics procedures, was obtained from parents or guardians of children who participated in the project. From all families approached, 68% agreed to participate in the study. Table 1 outlines the demographic characteristics of the sample.

TABLE 1
Demographic Characteristics of Sample

			Age in months		*Socioeconomic Status*	
Age Group	*n*	*Number of Boys*	*M*	*SD*	*M*	*SD*
3-year-olds	19	10	42	2	4.4	1.5
4-year-olds	19	10	53	3	4.6	1.1
5-year-olds	14	7	67	3	4.4	1.1
6-year-olds	22	13	77	3	4.2	1.1
7-year-olds	10	4	89	3	3.9	1.0

Note. No significant group differences were found regarding gender or socioeconomic status.

Socioeconomic status (SES) was obtained using Daniel's Scale of Occupational Prestige (Daniel, 1983), a widely used measure to assess the class position of occupations in Australian society. This scale rates SES from 1 to 7, with a lower score representing a higher SES.

Materials and Instructions

Practice trials. As a practice trial and introduction to the task, children were given two distinct bathtub toys (i.e., a yellow mouse with blue ears and a purple dinosaur with orange toes). After the child had examined the toys, the experimenter showed the child two toys identical to the first two and said

> See these toys? They are the same as the ones you have there, you see? The toys that are the same go together. Can you put the toys that go together on this side of the table (examiner points to one side of the table) and the other two that go together on that side of the table (examiner points to other side of the table)?

If the child did not understand these instructions, the examiner helped the child by asking

> So can you tell me which toys are the same? (Examiner waits for child to respond.) See, they go together because they are the same. And the other two also go together because they are the same as well. Now put these toys (examiner points to one pair of toys) on this side of the table and put the other two toys on that side of the table.

After the child had correctly placed the two matching pairs on either side of the table, the examiner showed the child two different sets of toys (i.e., a brown bear wearing a green hat and a blue fish with white eyes) and provided the following instructions, "Okay, now let's do the same thing with these toys. Can you put the ones that go together on this side of the table and the other two that are the same on that side of the table?" These practice trials were always presented with the same pairs of toys in the same order across all children in the sample.

Test trials. After the two practice trials, the examiner showed the child six plastic toys that could be sorted into two groups in three different ways (i.e., on the basis of color, size, or function). The six toys were a big red plane, a big red car, a big yellow car, a small red plane, a small yellow plane, and a small yellow car. The examiner provided the following instructions:

> Okay, now let's do the same thing with these toys. Can you make two groups for me? But something has to be the same about the toys in each group. Can you put one group on this side of the table and the other ones that go together on that side of the table?

If the child did not know what to do, or sorted the toys incorrectly, the examiner removed two toys, so that there were only four toys left (i.e., all cars). The OCTC was then administered using four toys, which could be sorted according to color or size. Thus, the OCTC could be administered with either six toys (Setting 1) or four toys (Setting 2), depending on the child's understanding and execution of task instructions when first shown the test toys.

Design and Procedure

Children who met the selection criteria described previously were administered the OCTC on an individual basis in a single session at their respective child care center, kindergarten, or primary school.

The OCTC included three conditions, each providing increasing levels of structure for the child: (a) free generation, where the child was required to generate categories with no clues or structure; (b) identification, where the examiner constructed the category for the child, and the child was asked to describe the rule used for the sort; and (c) explicit cueing, where the child received explicit instructions to group the toys. In the CGT–C (Jacobs et al., 2001), there was also a cued generation condition, where the child was given the rule for the sort and was asked to construct the categories according to that rule. In the OCTC, however, this condition was omitted, as the rule given by the examiner had to be provided in a manner similar to the explicit cueing condition so the child could understand the instructions. The level of structure within the two possible settings (i.e., six toys or four toys) was considered an indication of the child's capacity for conceptual reasoning.

Free generation condition. After the child had grouped the toys, he or she was asked, "So, can you tell me what's the same about these toys? [Examiner points to a group of toys.] And what's the same about these toys? [Examiner points to other group of toys.]" Responses were recorded verbatim. In the free generation condition, the child received 3 points for sorting correctly and 1 point for a correct verbal response. If the child did not group the toys according to one of the three dimensions, a score of 0 was given. If the child sorted the toys correctly, but gave an incorrect verbal response, a score of 3 was given. After the child had generated two groups, the examiner mixed up the toys, and the child was asked, "Can you make two groups for me again? But now something else has to be the same about the toys." After the child had grouped the toys according to a second dimension, he or she was once again asked, "So, what's the same about these toys? And what's the same about the other toys?" If children were able to correctly sort the toys by all three predetermined groupings, the task was deemed complete. The total number of points available for a setting with four toys is 8 (i.e., 6 points for two correct sorts and 2 points for the correct verbal responses). The total number of points available for a setting with six toys is 12 (i.e., 9 points for three correct sorts and 3 points for three correct verbal responses).

Identification condition. Children who were unable to correctly sort the toys using all three predetermined groupings in the free generation condition proceeded to the identification condition. In this condition, more structure was provided by constructing the category for the child and asking him or her to describe the rule used for the sort. Any of the groupings not correctly sorted in the free generation condition were administered in the identification condition. The examiner generated the groupings, and the child was asked, "See these two groups of toys? Can you tell me what's the same about these toys? [Examiner points to a group of toys.] And what's the same about these? [Examiner points to other group of toys.]" Responses were recorded verbatim. In the identification condition, the child received 2 points for a correct verbal response. If the child gave an incorrect verbal response, a score of 0 was given.

Explicit cueing condition. Children who failed to identify all sorts provided by the examiner proceeded to the explicit cueing condition, in which any of the groupings not correctly identified were administered. For instance, if the child did not correctly identify the sort according to color in the identification condition, the examiner asked the child, "Can you put all the red ones on this side of the table and all the yellow ones on that side of the table?" A score of 1 was given for each correct sort. If the child was not able to sort the toys, a score of 0 was given.

Statistical Analysis

A one-way analysis of variance was employed to investigate the main effect of age on the total number of points scored on the OCTC. Post hoc Tukey least significant difference pairwise comparisons were conducted to examine differences in performance between age groups. To further explore the relation between age and the total number of points on the OCTC, a linear trend analysis was performed. A frequency analysis was also conducted for each condition within each shifting attempt.

RESULTS

All of the children, including the 3-year-olds, passed the second practice trial of the OCTC. Although some children did not understand the instructions the first time they were given, they were able to successfully complete the second trial once the examiner had provided further instruction.

TABLE 2
Means, Standard Deviations, Ranges, *F* Ratio, and *p* Value of Total of Points on the Object Classification Task for Children Across Age Groups

	Age Group						
Variables	*3*	*4*	*5*	*6*	*7*	*F Ratio*	*p Value*
M	3.3	3.8	7.0	8.2	10.5	$F(4, 79) = 27.98$	.000
SD	2.3	2.7	2.0	2.1	1.6		
Range	0–7	0–7	4–10	5–12	7–12		

Effects of Age

Table 2 presents the results for the total of points, summed over all conditions, on the OCTC across age groups.

It was found that there was a main effect of age, $F(4, 79) = 27.98, p < .01$. Thus, it appears that performance on the OCTC increases as a function of increasing age. In particular, post hoc analysis revealed a significant increase in mean total of points between the 3- and 5-year-olds ($p < .01$) and between the 5- and 7-year-olds ($p < .01$). Figure 1 shows the data points for performance on the OCTC.

A Pearson correlation of the data revealed that age in months and total of points were significantly related, $r = .75, n = 84, p < .01$, two-tailed. A regression analysis was performed to explore the underlying trend of the relation between age and total of points. It was found that this relation can be expressed by a straight line that underlies this analysis. The equation for this line is given by: $Y = 0.17x - 4.49$, where Y is the outcome determined by this equation, and x is the age in months.

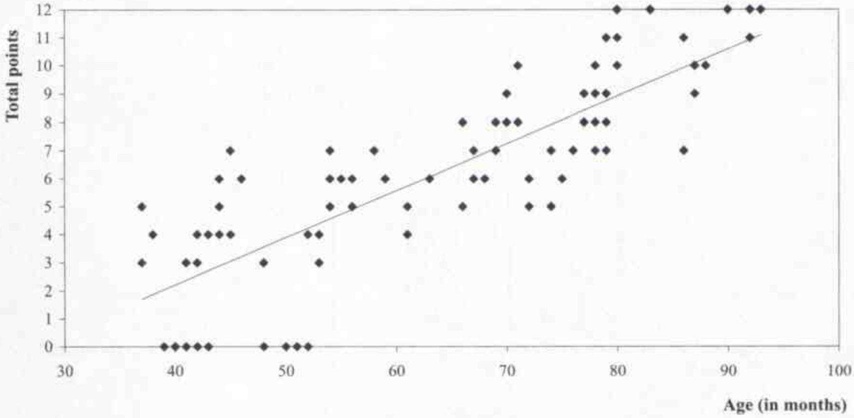

FIGURE 1 Data points and line of best fit for performance on the OCTC.

Thus, there is a linear trend for the data of the OCTC, with increasing performance as a function of increasing age.

Frequency Analysis

Although all children older than 4 years were able to sort six toys (Setting 1), some 3- and 4-year-olds were administered the OCTC with four toys (Setting 2). Figure 2 presents the proportion of 3- and 4-year-old children across the two settings of the OCTC.

There were 7 out of 19 children (37%) from the 3-year-old group who could sort the toys within a setting with six objects. Of the 12 children in Setting 2 (i.e., four toys), only 5 children (42%) could sort the toys correctly. As shown in Figure 2, 47% of the 4-year-olds could sort the toys in a setting with six objects. Of the 10 children in Setting 2, only 5 children (50%) could sort the toys correctly. Thus, for most children in the 3- and 4-year-old groups, the OCTC appeared to be too difficult using six toys. When the OCTC was administered with four toys, about half of the children could sort the toys correctly. However, none of these children were able to group the objects for a second time, according to a different feature.

Although all children older than 4 years were able to group six objects, when asked to group the toys for a second time, some children were dependent on structure provided by the examiner (i.e., identification or explicit condition). Figure 3 shows the proportion of children in each condition for the first switch (i.e., second sort) across age groups.

As shown in Figure 3, most 3- and 4-year-olds required explicit directions to group the toys for a second time and were not able to sort the toys independently. It must be noted that the only 3-year-old who grouped the objects without additional

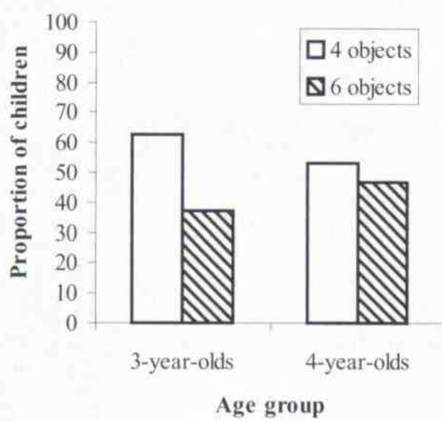

FIGURE 2 Proportion of 3- and 4-year-old children across settings of the OCTC.

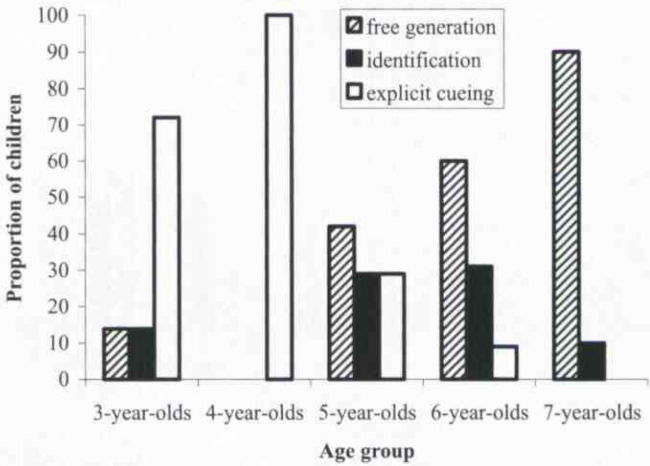

FIGURE 3 Proportion of children in each condition for first switch on the OCTC across age groups.

structure (i.e., free generation condition) appeared to be unaware that he had sorted the objects correctly. Although all 4-year-olds required explicit instructions to group the toys, 5-year-olds required less structure to do so. In particular, 42% of the children in this age group could sort the objects without additional structure, 29% of the children could identify a second concept when the examiner had grouped the toys for them, and the remaining 29% of the children required explicit instructions. A chi-square analysis revealed that there were significantly more children in the 7-year-old group who could sort the toys independently, when compared to the 5-year-olds, χ^2 (1, $n = 24$) = 5.54, $p < .05$. No other significant differences were found across age groups or conditions.

Figure 4 shows the proportion of children in each condition for the second switch (i.e., third sort) across age groups.

As shown in Figure 4, all children from the 3- and 4-year-old groups required explicit instructions to group the toys for a third time. In contrast, older children required less structure to perform this task. In particular, a chi-square analysis showed that there were significantly more 7-year-olds who could group the toys independently, when compared to 5-year-olds, χ^2 (1, $n = 24$) = 5.71, $p < .05$. No other significant differences were found for any of the age groups or conditions.

A few children ($n = 5$) generated valid sorts that were not included in the three predetermined groupings. These sorting categories included little wheels–big wheels and moving wheels–nonmoving wheels. These categories were considered as correct groupings. No child generated extra sorts in addition to correctly generating all three predetermined sorts.

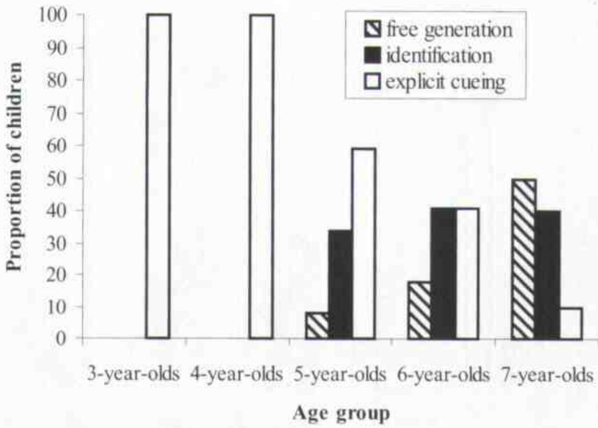

FIGURE 4 Proportion of children in each condition for second switch on OCTC across age groups.

DISCUSSION

Although several studies have investigated the development of conceptual reasoning skills in children older than 7 years, relatively little is known about how these processes mature in younger children. The assessment of conceptual reasoning skills in this age group has been hampered by the paucity of appropriate neuropsychological measures to assess these skills in young children. In this study, the development of concept generation and mental flexibility was investigated in children between 3 and 7 years, using the OCTC, a newly developed executive function test for use with young children. On the OCTC, which was adapted from the CGT (Levine et al., 1995) and the CGT–C (Jacobs et al., 2001), children were required to sort six nonidentical toys according to three predetermined groupings (i.e., color, size, and function). Findings from this study confirm our hypotheses and suggest that the OCTC is a useful measure of conceptual reasoning skills in young children. In particular, the results from this task reveal age-related changes in overall performance across the entire age range, providing a clear picture of developmental changes in concept generation and mental flexibility during early childhood. The two settings of the OCTC (i.e., four toys and six toys), and the use of different levels of structure within these settings, allowed for a detailed analysis of the performance of children between 3 and 7 years. The greatest improvement in performance was observed between the 4- and 5-year-old groups, indicating a rapid developmental progression of concept generation and mental flexibility in the period between 4 and 5 years of age.

Even the youngest children passed the practice trials, indicating that they were capable of grouping four objects according to overall appearance, although the majority of 3-year-olds experienced difficulty sorting the test toys according to a particular feature. This finding suggests that 3-year-olds have difficulty identifying a common feature within a group of nonidentical objects. Even when the number of dimensions was reduced to two (i.e., color and size) in a setting with only four toys, most children from the 3-year-old group were unable to perform the task. In contrast, almost half of the children in the 4-year-old group could identify a common dimension within a group of six toys, suggesting that 4-year-old children have less difficulty generating concepts, when compared to 3-year-olds. The results from this study show that all children older than 4 years were able to sort six toys according to a certain feature, indicating that these children are able to identify a common dimension within a group of different objects. Similar findings were reported by Jacques and Zelazo (2001), who used the FIST to investigate abstraction and cognitive flexibility in preschoolers. Jacques and Zelazo showed that, despite good performance on the criterial trials, where children were required to match identical cards, 3-year-olds performed poorly when required to identify a common dimension in two nonidentical cards. Jacques and Zelazo reported that, in contrast to 3-year-olds, most 4-year-olds experienced no difficulty recognizing how two nonidentical cards could match according to a particular feature. Thus, between the ages of 3 and 4 years, there appears to be a developmental change in the ability to abstract information from nonidentical items. This finding is consistent with the notion that young children primarily use concrete information as the basis for categorization (e.g., Flavell, 1985; Inhelder & Piaget, 1964). It is believed that it is not until later in life that categorization occurs on the basis of more abstract, conceptual–lexical information (e.g., Bruner, Olver, & Greenfield, 1966).

The results of the OCTC showed that, when required to spontaneously shift between concepts, none of the 4-year-old children were successful. All children from this age group required explicit instructions to group the toys, suggesting that 4-year-olds are unable to group six toys according to a second, different dimension. The majority of 5-year-olds were able to identify a second concept, albeit with additional structure provided by the examiner. In their study on abstraction and cognitive flexibility, Jacques and Zelazo (2001) found that 4-year-olds did worse on the shifting component of the FIST when compared to 5-year-olds, in keeping with our finding that there appears to be a developmental progression in mental flexibility between the ages of 4 and 5 years.

The OCTC was also used to assess children's ability to shift multiple times between different dimensions. Results from this study show that older children require less structure in completing the task when compared to younger children, suggesting a refinement of cognitive flexibility skills between the ages of 5 and 7 years. A better performance on the OCTC is reflected by the ability to shift between an increasing number of concepts, and to generate a dimension more complex than the fundamental concepts of color and shape. However, even the oldest children in our sample experienced difficulty generating a third concept without any additional structure provided, although the majority of these children could independently group the toys according to a second dimension. Thus, although 7-year-olds may be able to shift between *two* concepts, they appear to experience difficulty when they are required to shift between *three* concepts. These findings suggest that conceptual reasoning skills continue to develop beyond the age of 7 years. Support for this notion has come from a recent study conducted by Jacobs et al. (2001), who investigated the development of conceptual reasoning in children between the ages of 7 and 15 years, using the CGT–C, a similar, but more complex task than the OCTC. It was found that unstructured sorting and shifting was most difficult for children younger than 9 years, with only the oldest age group performing in line with adult expectations. Thus, it appears that the developmental course of conceptual reasoning follows a progression that is characterized by periods of growth spurts between 4 and 5 years and between 7 and 9 years. The ability to shift, as measured by the OCTC, appears to undergo different developmental gains when compared to other executive processes, such as inhibition, where growth spurts have primarily been identified in children younger than 6 years (Smidts & Anderson, 2003).

It must be noted that the failure of 3-year-old children to group the test toys could also be due to limited knowledge about the semantic components (i.e., color, size, and function) of the objects. Older children may perform better on the task because they have an established understanding of physical and functional properties of objects. Ample evidence exists for the notion that during early childhood, children acquire a range of linguistic capacities, such as increased vocabulary and use of grammatical rules, which are believed to be key processes in efficient functioning and essential for learning (e.g., Chen-Hafteck, 1997; Farrar & Maag, 2002; D. Molfese & V. Molfese, 2000). A study investigating the relation between verbal responses and sorting behavior on the OCTC is currently in progress.

Alternatively, younger children may have experienced difficulty shifting between concepts due to the immaturity of other skills within the domain of executive function. For example, older children may perform better on the task because they are able to selectively attend to the features of the objects and exercise more inhibitory control over their behavior, skills that are necessary to shift between concepts. Several developmental studies have shown that during early childhood, children become more capable in exercising inhibitory control over their behavioral actions (e.g., Becker, Isaac, & Hynd, 1987; Passler, Isaac, & Hynd, 1985). More research with the OCTC, however, is required to investigate these issues.

In summary, analysis of age trends in performance on the OCTC identifies a developmental course of conceptual reasoning skills in early childhood. In particular, results from this study suggest that the ability to generate concepts emerges between the ages of 3 and 4 years, continuing to develop beyond the age of 7 years.

Further, a developmental spurt in mental flexibility was observed around 4 to 5 years of age, with refinement of this capacity occurring between 5 and 7 years of age. Findings from this study show that the OCTC, which was specifically designed for use with children between 3 and 7 years, and did not show any floor or ceiling effects, appears to be a useful tool for the investigation of concept generation and mental flexibility in early childhood, and it may be a useful adjunct to the paucity of executive function tests available for this age range.

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